

THE ATREE CODE AND DATABASE  
SYSTEM FOR ANALYSIS OF RADIATION  
EFFECTS ON ELECTRONICS



*Science Applications International Corporation*  
*An Employee-Owned Company*

SAIC Canada Report Number 89/01  
SAIC Canada Final Report for Contract W7714-9-5913

22 December 1989

T.J. Jamieson  
A.L. Friedman

## TABLE OF CONTENTS

	Section	Page
	Foreword	
1	Introduction	1
2	Radiation Effects on Electronics	2
	2.1 Data Presented	
	2.2 Data Sources	
	2.3 Notes on the Use of the Data	
3	Use of the Code and Database System	5
	3.1 Executing an ATR5 Run	
	3.2 Entering Parts Data	
	3.3 Viewing Parts Data	
	3.4 Analyzing the Effects of Radiation on a Part	
	3.5 Entering System Data	
	3.6 Viewing System Data	
	3.7 Analyzing the Effects of Radiation on a System	
	3.8 Expanding the Radiation Fields Database	
4	References	9
	Appendix A - Programs Contained in the ATREE System	10
	Appendix B - Structure and Contents of the Databases Contained in the ATREE System	11
	Appendix C - Parts Included the PARTS.DBF Database	15

## FOREWORD

A radiation response database and database program, called ATREE, for analyzing transient radiation effects on electronics has been developed. Neutron fluence, total dose and gamma dose rate effects can be determined by the system.

The system is capable of storing and analyzing data pertaining both to individual electronic components and entire systems. Representative data for 23 types of components have been included.

Utility programs are included in the ATREE system to facilitate the preparation and processing of ATR5 analyses as required to generate the radiation environment data corresponding to the user-specified source type and problem geometry.

The system is user friendly and was designed so as to be easily updated or expanded.

## 1 INTRODUCTION

The radiation effects data base described below is intended to illustrate changes in basic performance characteristics of a variety of semiconductor devices when exposed to the various battlefield radiation environments. These environments are total ionizing dose, transient dose rate, and neutron fluence. The electrical parameters selected to demonstrate the effects of radiation are the key factors for each device type which are fundamental to design integrity in typical circuit applications. These are intended to be illustrative rather than comprehensive. The range of device types shown represent the majority of those in common usage and provide a basis for generalizing characteristics across families of parts fabricated with similar process technologies.

A database program has been designed to interrogate this database, to display the results of radiation analyses using the data and to allow expansion of the database. Other related programs have been designed to allow the definition and analysis of electronic systems containing any number of parts, and to allow the execution and processing of ATR5 analyses in order to create a database of radiation environments.

The radiation effects database, the radiation environments database, the systems definition database and the related database programs comprise the ATREE code and database system.

## 2 RADIATION EFFECTS ON SEMICONDUCTORS

### 2.1 DATA PRESENTED

The data presented here represent the range of discrete and integrated circuit components found in military electronic systems in today's inventories. Various semiconductor technologies such as bipolar and field effect processing are shown. Under the bipolar, various forms of transistor-transistor logic (TTL) are listed. Field effect processes include uni-channel (n and p) and complementary MOS (CMOS) as well as junction (JFET) devices. In general, performance under exposure to three radiation environments is shown: total dose, neutrons, and dose rate. In a few cases, where data was obtained from NASA or other sources intended for spacecraft or other limited usage, data for all three environments for a particular part was unavailable.

The following types and quantities (in brackets) of parts are represented in the data base:

#### Diodes

- switching (1)
- rectifier (1)
- thyristor (SCR) (1)
- zener (1)

#### Transistors

- switching (2)
- power (2)
- JFET (1)
- MOSFET (1)

#### Integrated Circuits

##### Non-memory

- linear (1)
- interface (1)
- digital (2)
- microprocessor (3)

##### Memory

- RAM (3)
- PROM (2)
- EPROM (1)

### 2.2 DATA SOURCES

Data contained in the data base is derived from three primary sources. These are Harry Diamond Laboratories which has transferred its data to DASIAC under the Defense Nuclear Agency (1,2); NASA-JPL (3); and Nuclear and Space Radiation Effects Conference papers collected in the December issues of the IEEE Transactions on Nuclear Science (4). Experience with radiation testing and familiarity with applications of radiation effects data was used to select the key parameters to be displayed in the data base. The raw data from which the ATREE database was extracted is included as an attachment to this report.

### 2.3 NOTES ON THE USE OF THE DATA

A number of important factors must be considered when interpreting radiation effects data such as that presented in the data base. These factors affect the ability of the user to assess the relationship between data base parameter values and radiation effects performance of a purchased part with the same part number. Large safety factors are required when data is used without regard to the qualifications discussed below. Where large margins are not acceptable for specific applications, radiation testing of selected parts is required. Factors to be considered are:

- Parts
- Testing
- Data

Parts - Components with identical part numbers have, by definition, identical electrical specifications but may differ in packaging or processing without differing in published parameters. Acquisition of non-radiation hardened semiconductor devices by commercial or military part numbers assures similarity of electrical performance but not of radiation response characteristics between parts of different manufacturers. The reason why parts do not necessarily exhibit identical radiation performance is due to the fact that radiation susceptibility is dependent on process and design factors which are not necessarily controlled or may not have been evaluated with respect to radiation performance in the initial design stages. Furthermore, ongoing processing modifications for yield enhancement may have significant impact on radiation characteristics and can result in either improved or degraded performance. The result of a process change on radiation performance cannot be predicted unless it is identified, analyzed, and in many cases, the parts are retested. Thus, radiation test data can apply specifically only to the parts tested and others of identical processing. For other manufacturers' similar parts the data may be viewed as a general indication of performance when different processing is likely. Processing changes are probable when test data is old or when multiple sources are utilized in a procurement.

Testing - A number of factors associated with radiation testing affect the repeatability of test data when identical parts are tested by different organizations and at different facilities. These are type of radiation source, spectrum, dosimetry, test fixtures, and noise. Transient testing requires real time data collection and frequency response of the measurement system is determined by cable type, length, terminations, drivers and receivers, and by the recording instrumentation. Differences in test conditions and instrumentation can cause variations in test results. Transient testing that does not reveal latchup in junction isolated four layer semiconductors does not imply that

latchup cannot occur under other operating conditions. Specific design and processing techniques are necessary to unequivocally rule out the possibility of latchup. Permanent damage effects derived from total dose and neutron tests are impacted by temperature and storage time between exposure and testing. Furthermore, radiation deposition rate has been found to be critical in assessing these effects. Present specifications control these factors but older data may be suspect if test conditions are not known.

Data - Representation of radiation responses by single parametric values tends to mask the characteristics of the data derived from multiple samples. Listing standard deviations helps in this regard but only if the statistical nature of the parameter value is given and the data is reasonably normally distributed. Small sample data are subject to the vagaries of parts selection as to validity of the sample as being representative of the population. Lot code data is an aid in evaluating the breadth of the sample. The operating conditions under which data was collected are critical to evaluating specific applications. Factors such as temperature, supply voltage, current, loading, and noise must be considered when comparing test results of similar circuits. In the ATREE database, where multiple raw test data was available, the data reported is that at the maximum radiation level. This has the effect in most cases of maximizing the reported performance change. Also, to simplify the database, standard deviations are not quoted, but rather the sample size is included as a measure of data reliability.

### 3 USE OF THE CODE AND DATABASE SYSTEM

With the exception of the execution of an ATR5 analysis, all functions in the ATREE system are executed as database programs written in the dBASE language and compiled using the database compiler Clipper.

As such, the database program can be run either from within the dBASE language or as a standalone program compiled by Clipper, according to the preference of the user.

As a dBASE program, the TREE database program can be executed by entering dBASE, and issuing a "DO" command. The appropriate command for the ATREE system is "DO TREE". As a standalone Clipper program, the TREE database program can be executed by issuing the command "TREE" at the DOS prompt. The reader is referred to the dBASE language manual and the Clipper compiler manual for fuller discussions on the general operation of these software packages.

Appendix A summarizes the role of each program within the ATREE system. Appendix B summarizes the structure and content of each database within the ATREE system.

An explanation the use of each of the ATREE system programs follows.

#### 3.1 EXECUTING AN ATR5 RUN

ATR5 analyses are required to generate the radiation environments defined by the user-specified source/receptor configurations. In the ATREE code system, two tools are provided to facilitate the use of ATR5:

PREPARE: Determines the source type and source/receptor geometry in order to prepare an ATR5 input set. Allowable source types are fission and fusion.

PROCESS: Processes an ATR5 output file and extracts the neutron fluence, total dose and gamma dose rate as required by ATREE. The gamma dose rate is calculated assuming a pulse width of 0.01 microseconds. The output from PROCESS is either a file containing these parameters (a "full process" of the ATR5 output), or simply a copy of the entire output file. If only the radiation environment parameters are saved, the file can be accessed through the main database program in order to update the radiation environments database (see Section 3.8).



Both these tools were written in FORTRAN and are executed as stand-alone programs outside of dBASE or Clipper. All input to these routines is provided interactively by the user. The DOS batch file ATREE.BAT is provided to activate these programs and execute ATR5.

Note that ATR5 runs are performed outside of the main ATREE analysis, and are only required if the user wishes to calculate and employ in a subsequent ATREE analysis the radiation fields established by a given source/receptor geometry.

The pulse width employed is consistent with the unclassified data discussed in Reference 5. The actual value of 1 shake was chosen to facilitate scaling to any specific pulse width (if available).

### 3.2 ENTERING PARTS DATA

The entering of parts data is accomplished through the main menu of the TREE database program. The program prompts the user for the required information in each of the 42 possible fields comprising each part record. A description of the information required in each field is given in Appendix B.

Note that the lengths associated with any of the data fields in the parts records can easily be changed (for example, if longer part number identifiers are required).

Failure to supply information for all the required fields will result in loss of functionality in the analysis portion of ATREE. Note that if no information is available for a given radiation environment type (e.g. total dose), the user must enter a value of 0 as the control code in the relevant results field (i.e. in RESULTS11, RESULTS21 or RESULTS31) in the database record.

The ATREE system maintains a separate database (TYPES.DBF) consisting of the types of distinct parts contained in the main database. In order to assure the correct updating of this database as new part records are entered, the user must only enter 1 new part type at a time through the add parts option. Multiple records for a single new part type (typically occurring if more than one manufacturer exists) can, however, be entered at the same time.

### 3.3 VIEWING PARTS DATA

The viewing of parts data is accomplished through the main menu in the TREE database program. The user has the choice of viewing a specific part number (such as 1N3600), determining the part numbers for a given device type (e.g. switching diodes have part number 1N3600) or viewing all available part types in the system

(e.g. switching diodes, transistors, RAM chips, etc).

In cases where multiple records exist for a given part number, such as in the case of multiple manufacturers, the multiple records are displayed in sequence.

In cases where a user-specified part number or part type does not exist in the database, an appropriate message is displayed on the screen. In such an event, the user is advised to select option 3 to determine the available part types, followed by option 3 to determine the specific part number.

In the database as supplied with ATREE, a total of 42 part records covering 23 distinct part types are available.

### 3.4 ANALYZING THE EFFECTS OF RADIATION ON A PART

The analysis of the radiation effects on a part is initiated through the main ATREE menu. The sub-menu options allow the user to select a part number, select the radiation field parameters (i.e source type and geometry) and to display the results of the analysis.

In selecting a part type, the user must enter a part number which exists in the database (see Section 3.3) or else an error message is displayed. In cases where multiple manufacturers exist for a given part number, the user must select the manufacturer.

The selection of the radiation field parameters involves specifying the source type (either fission or fusion) as well as the required yield and geometry data. If the required environment cannot be found in the FIELDS.DBF database, an error message is displayed,

The analyze option extracts the various radiation parameters (i.e. neutron fluence, total dose and gamma dose rate) from the radiation environment database and presents these results on the screen. Along with this data, the user is prompted to enter the type of parameter for which a detailed display of the part response is desired. For example, if the user selects the neutron fluence option, the fluence effects on the given part and the corresponding test fluence level are displayed. If no data is available (i.e. a results code of 0 in the database), an informative message is displayed.

A full results screen thus presents the user with a summary of the radiation parameters for the specified radiation environment and the test results for the part as observed at the test level. Extrapolation of the part test results to the specified radiation environment is left to the user.

### 3.5 ENTERING SYSTEM DATA

The entering of systems data is accomplished through the main menu of the TREE database program. The program prompts the user for the required information in each of the fields comprising each system record.

A description of the information required in each field is given in Appendix B. As currently implemented, a maximum of nine parts can be specified for any system, however this is an arbitrary limit and can easily be expanded.

### 3.6 VIEWING SYSTEM DATA

The viewing of systems data is accomplished through the main menu in the TREE database program. The user has the choice of viewing a specific system (such as "field radio") or viewing all available systems in the database.

### 3.7 ANALYZING THE EFFECTS OF RADIATION ON A SYSTEM

This option is not activated in the current version of ATREE. System analysis can, however, be performed through separate parts analysis of the system components.

### 3.8 EXPANDING THE RADIATION FIELDS DATABASE

Expansion of the radiation fields database FIELDS.DBF is accomplished through the main menu. For this option, a sub-menu listing the two possible methods of expansion is displayed.

In method 1, the manual update method, the user is prompted interactively for the required data. Such data would typically be calculated separately outside ATREE by some other tool (such as ATR5 or DOT).

In method 2, the automatic expansion method, ATREE searches for the file EXPAND.DAT which is created (or expanded) each time the PREPARE and PROCESS (with full output processing) programs are used outside ATREE.

Appendix B describes the fields comprising the FIELDS.DBF database.

## 4 REFERENCES

- (1) Nuclear Radiation Effects on LSIC; H. Eisen, et al; 1984 Supplement; HDL-DS-84-1; May 1984.
- (2) Radiation Effects on Semiconductor Devices; H. Eisen, et al; HDL-DS-82-1; October 1982.
- (3) Total Dose Radiation Effects for Semiconductor Devices; K.E. Martin, et al; 1985 Supplement, JPL-85-43; Vol. I, October 1985; Vol II, May 1986.
- (4) Transient Radiation Characterization of Commercial 16K PROM's; A. Friedman, et al; Nuclear and Space Radiation Effects Conference, July 1983.
- (5) CG-W-4, Joint DOD/DOE Nuclear Weapons Classification Guide.

## APPENDIX A - PROGRAMS CONTAINED IN THE ATREE SYSTEM

### A.1 DATABASE PROGRAMS

The majority of the ATREE system executes from within the dBASE or Clipper languages. The following modules are used:

- TREE: Controls the general execution of an ATREE session, allows for part and system data entry and calls the other modules as required.
- VIEWPART: Allows the user to view the data for a given part number, to view all parts of a given type or to view all part types.
- ANAPART: Controls the selection of parts and weapons environments for a parts radiation analysis, and displays the results.
- VIEWSYS: Allows the user to view a given system.
- ANASYS: Performs radiation analysis for systems (similar to ANAPART)
- EXPAND: Allows the user to manually expand the radiation environments data base from existing ATR5 analyses or to automatically expand the database using the results of the PROCESS code.

### A.2 STAND-ALONE PROGRAMS

In addition to the database programs, three stand-alone programs written in FORTRAN form part of the ATREE system:

- PREPARE: Prompts the user for the minimum ATR5 input required to determine the radiation parameters used by ANAPART. PREPARE can also be used as a general tool for preparing ATR5 inputs for other applications.
- PROCESS: Processes the results of an ATR5 analysis in a form compatible for use by the EXPAND program. As an option, PROCESS will simply save an ATR5 output file under a filename as supplied by the user.
- DISPLAY3: Used by ANAPART to display the results of ATREE analysis. Note that DISPLAY3 is called by TREE, so is not truly stand-alone.

## APPENDIX B - STRUCTURE AND CONTENTS OF THE DATABASES CONTAINED IN THE ATREE SYSTEM

### B.1 PARTS.DBF

The database file PARTS.DBF contains the bulk of the TREE database information, namely the radiation responses of the components. Data for each part is contained in a separate record comprised of 42 data fields.

The first three fields in each part record contains the part type (e.g. diode), the part number (e.g. 1N3600) and the manufacturer (e.g. Fairchild).

The next 13 fields pertain to the neutron fluence effects data. The first six of these fields contain the sample size used in the test, the manufacturer's lot codes, the test date, the radiation facility where the test was performed, details of the irradiation and any relevant test conditions. Following these fields is a control code field describing the type of test information which follows, five data fields holding the actual radiation response data, and, finally, a field for the reference or source of this information.

These 13 fields are repeated in turn for the total dose and gamma dose rate effects.

The structure of the database follows:

FIELD_NAME	FIELD_TYPE	FIELD_LEN	FIELD_DEC
TYPE	C	25	0
NUMBER	C	20	0
MAKER	C	20	0
SAMPL_SIZE1	N	3	0
LOT_CODES1	C	10	0
TEST_DATE1	D	8	0
FACILITY1	C	40	0
RAD_DATA1	C	40	0
TEST_CON1	C	120	0
RESULTS11	N	3	0
RESULTS12	C	12	0
RESULTS13	C	12	0
RESULTS14	C	12	0
RESULTS15	C	12	0
RESULTS16	C	12	0
REFERENCE1	C	120	0
SAMPL_SIZE2	N	3	0
LOT_CODES2	C	10	0
TEST_DATE2	D	8	0
FACILITY2	C	40	0

RAD_DATA2	C	40	0
TEST_CON2	C	120	0
RESULTS21	N	3	0
RESULTS22	C	12	0
RESULTS23	C	12	0
RESULTS24	C	12	0
RESULTS25	C	12	0
RESULTS26	C	12	0
REFERENCE2	C	120	0
SAMPL_SIZ3	N	3	0
LOT_CODES3	C	10	0
TEST_DATE3	D	8	0
FACILITY3	C	40	0
RAD_DATA3	C	40	0
TEST_CON3	C	120	0
RESULTS31	N	3	0
RESULTS32	C	12	0
RESULTS33	C	12	0
RESULTS34	C	12	0
RESULTS35	C	12	0
RESULTS36	C	12	0
REFERENCE3	C	120	0

The control code describing the type of information in the results records currently can take any one of the following values:

#### CODE            CONTENTS OF RESULTS RECORDS

- 1      leakage current, rad level, forward voltage, rad level
- 2      transient photocurrent, rad level
- 3      leakage current, rad level, delta breakdown voltage, rad
- 4      turn-on voltage at 50, 100, 200 and 300 mA, rad level
- 5      TPLH, TPHL, VOL, VOH, rad level
- 6      rad level for logical 0 corrupt and logical 1 corrupt
- 7      BIAS1, OFSTI, OFSTV, VGAIN, rad level
- 8      NDLVO, PDLVO, TR, DLIPS, rad level
- 9      (no longer used)
- 10     DCHFE, VSAT, leakage current, rad level
- 11     IGSS, IDOFF, VGSOFF, RDSON, rad level
- 12     IDD, VTN, VTP, rad level
- 13     latchup, upset and failure levels  
(a negative value indicates no effect at stated level)
- 14     IDSS, VGS, RDSON, rad level
- 0      no data available

The abbreviations for the results fields information and for the radiation facilities can be found in the source material supplied with this report.

## B.2 SYSTEMS.DBF

The database file SYSTEMS.DBF contains the information defining the parts and part numbers for the components comprising a given electronic system. The structure of the database follows:

FIELD_NAME	FIELD_TYPE	FIELD_LEN	FIELD_DEC
NAME	C	20	0
PART1NUM	C	20	0
PART1TYPE	C	20	0
PART2NUM	C	20	0
PART2TYPE	C	20	0
PART3NUM	C	20	0
PART3TYPE	C	20	0
PART4NUM	C	20	0
PART4TYPE	C	20	0
PART5NUM	C	20	0
PART5TYPE	C	20	0
PART6NUM	C	20	0
PART6TYPE	C	20	0
PART7NUM	C	20	0
PART7TYPE	C	20	0
PART8NUM	C	20	0
PART8TYPE	C	20	0
PART9NUM	C	20	0
PART9TYPE	C	20	0

Currently, a maximum of 9 parts can be specified for any system.

## B.3 TYPES.DBF

The database file TYPES.DBF contains a list of unique part types (e.g. switching diode, transistor) used by the VIEWPART program. The structure of the database follows:

FIELD_NAME	FIELD_TYPE	FIELD_LEN	FIELD_DEC
UNIQUETYPE	C	25	0



#### B.4 FIELDS.DBF

The database file FIELDS.DBF contains the results of ATR5 analyses for various source and detector configurations. The device field can be either fission or fusion. The yield field contains the device yield in kilotons. The height field contains the burst height in meters. The range field contains the source/receptor horizontal separation in meters. The elevation field contains the receptor elevation in meters. The final three fields contain neutron fluence, total dose and gamma dose rate as calculated by ATR5, where the gamma dose rate assumes a pulse width of 0.01 microseconds.

The structure of the database follows:

FIELD_NAME	FIELD_TYPE	FIELD_LEN	FIELD_DEC
DEVICE	C	10	0
YIELD_KT	C	10	0
HEIGHT_M	C	10	0
RANGE_M	C	10	0
ELEVATION	C	10	0
NEUTRON	C	10	0
TOTAL	C	10	0
GAMMARATE	C	10	0

## APPENDIX C - PARTS INCLUDED IN THE PARTS.DBF DATABASE

A total of 42 parts are currently included in the parts database:

<u>PART TYPE</u>	<u>PART NUMBER</u>	<u>MANUFACTURER</u>
switching diode	1N3600	fairchild
switching diode	1N3600	continental device
zener diode	1N752A	continental device
zener diode	1N752A	motorola
zener diode	1N752A	trw
rectifier-400v-12a	1N3893	motorola
scr	2N1871A	transitron elec. cor
ttl and-or gate	SN54L51	texas instruments
ttl and-or gate	DM54L51	national semiconduct
op amp	LM101	national semiconduct
npn switching transistor	2N2222	trw
npn switching transistor	2N2222	fairchild
npn switching transistor	2N2222	motorola
pnP switching transistor	2N2905A	texas instruments
pnP switching transistor	2N2905A	fairchild
pnP switching transistor	2N2905A	motorola
npn power transistor	2N5004	texas instruments
pnP power transistor	2N5005	fairchild
dual flip-flop -- cmos	CD4013	rca
n-channel jfet transistor	2N4391	siliconix
dual flip-flop -- cmos	CD4013	solid state scientif
8 bit cmos i/o port	MM82PC12J	national semiconduct
cmos prom 256x4	6611	harris
nmos 4kx8 uv eprom	2732DMB	advanced micro devic
nmos 64k dynamic ram	4164	texas instruments
mos power transist-hexfet	1RF150	internat. rectifier
cmos 2kx8 static ram	6116	integrated devices t
cmos 2kx8 static ram	6116	hitachi
4 bit sttl microprocessor	AM2901DC	advanced micro devic
4 bit sttl microprocessor	AM2901ADM-B	advanced micro devic
16k sttl prom	93Z511DC	fairchild
8 bit cmos microprocessor	1802	sandia labs
8 bit cmos microprocessor	cdpl802	rca
hmos 4kx1 static ram	2147	intel
hmos 4kx1 static ram	C2147	inl/itl
4kx1 hmos static ram	MCM2147	national semiconduct
8086 nmos microprocessor	D8086	intel
8086 nmos microprocessor	D8086D	intel
8086 nmos microprocessor	D8086D	nec
8086 nmos microprocessor	MD8086	intel
8086 nmos microprocessor	MD8086/B	intel
8086 nmos microprocessor	MD8086/B	advanced micro devic

UNCLASSIFIED

SECURITY CLASSIFICATION OF FORM  
(highest classification of Title, Abstract, Keywords)

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

<p>1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Establishment sponsoring a contractor's report, or tasking agency, are entered in section 8.)</p> <p>SAIC CANADA 275 SLATER STREET, SUITE 705 OTTAWA, ONTARIO K1P 5H9</p>		<p>2. SECURITY CLASSIFICATION (overall security classification of the document, including special warning terms if applicable)</p> <p>UNCLASSIFIED</p>	
<p>3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S,C,R or U) in parentheses after the title.)</p> <p>THE ATREE CODE AND DATABASE SYSTEM FOR ANALYSIS OF RADIATION EFFECTS ON ELECTRONICS (u)</p>			
<p>4. AUTHORS (Last name, first name, middle initial)</p> <p>JAMIESON, TERRANCE J. FRIEDMAN, ARTHUR L.</p>			
<p>5. DATE OF PUBLICATION (month and year of publication of document)</p> <p>22 DECEMBER 1989</p>		<p>6a. NO. OF PAGES (total containing information. Include Annexes, Appendices, etc.)</p> <p>17</p>	<p>6b. NO. OF REFS (total cited in document)</p> <p>5</p>
<p>7. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)</p> <p>TECHNICAL REPORT</p>			
<p>8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address.)</p> <p>DEFENCE RESEARCH ESTABLISHMENT OTTAWA ELECTRONICS DIVISION NUCLEAR EFFECTS SECTION</p>			
<p>9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant)</p>		<p>9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written)</p> <p>CONTRACT W 7714-9-5913</p>	
<p>10a. ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)</p> <p>SAIC CANADA REPORT NUMBER 89/01</p>		<p>10b. OTHER DOCUMENT NOS. (Any other numbers which may be assigned this document either by the originator or by the sponsor)</p>	
<p>11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification)</p> <p><input checked="" type="checkbox"/> Unlimited distribution <input type="checkbox"/> Distribution limited to defence departments and defence contractors; further distribution only as approved <input type="checkbox"/> Distribution limited to defence departments and Canadian defence contractors; further distribution only as approved <input type="checkbox"/> Distribution limited to government departments and agencies; further distribution only as approved <input type="checkbox"/> Distribution limited to defence departments; further distribution only as approved <input type="checkbox"/> Other (please specify):</p>			
<p>12. DOCUMENT ANNOUNCEMENT (any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in 11) is possible, a wider announcement audience may be selected.)</p>			

UNCLASSIFIED

SECURITY CLASSIFICATION OF FORM

DCD03 2/06/87

13. ABSTRACT ( a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual).

A radiation response database and database program, called ATREE, for analyzing transient radiation effects on electronics has been developed. Neutron fluence, total dose and gamma dose rate effects can be determined by the system.

The system is capable of storing and analyzing data pertaining both to individual electronic components and entire systems. Representative data for 23 types of components have been included.

Utility programs are included in the ATREE system to facilitate the preparation and processing of ATR5 analyses as required to generate the radiation environment data corresponding to the user-specified source type and problem geometry.

The system is user friendly and was designed so as to be easily updated or expanded.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus. e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

AIR TRANSPORT OF RADIATION  
TRANSIENT RADIATION EFFECTS ON ELECTRONICS (TREE)  
COMPUTER CODE  
NUCLEAR EFFECTS  
RADIATION RESPONSE  
TREE DATABASE